WHAT IS CLAIMED IS:

1. An air seal for use in a gas turbine engine having improved durability, comprising:

a seal substrate; and

an abradable seal layer on the seal substrate, said abradable seal layer being composed of a densified polyimide foam.

2. An air seal according to claim 1, wherein said abradable seal layer has at least one layer of said densified polyimide foam.

3. An air seal according to claim 1, wherein said abradable seal layer comprises a plurality of layers of said densified polyimide foam.

4. An air seal according to claim 1, wherein said polyimide foam has a density of at least 10 pounds per cubic foot.

5. An air seal according to claim 1, wherein said polyimide foam has a density of at least 15 pounds per cubic foot.

6. An air seal according to claim 1, wherein said polyimide foam has a density in the range of from 12 pounds per cubic foot to 25 pounds per cubic foot.

7. An air seal according to claim 1, wherein said polyimide foam has a shear strength of 140 psi to about 325 psi.

8. An air seal according to claim 1, wherein said seal substrate comprises a polymer composite.

9. An air seal according to claim 1, wherein the air seal is an outer air seal.

10. An air seal according to claim 1, wherein the air seal is a knife edge seal.

11. An air seal according to claim 1, wherein the densified polyimide foam is a thermomechanically densified polyimide foam.

12. A gas turbine engine seal system comprising:

a seal assembly having a seal substrate and an abradable seal material applied to a bond layer;

said abradable seal material being composed of a densified polyimide foam; and

an engine component adapted for motion relative to the seal assembly and having an abrasive portion interacting with the abradable seal material, whereby the abrasive portion of the engine component and the abradable seal material of the seal assembly cooperate to provide sealing.

13. A gas turbine engine seal system according to claim 12, wherein said seal substrate comprises a stator box and said engine component comprises a disk.

14. A gas turbine engine seal system according to claim 12, wherein said seal substrate comprises a portion of a case and said engine component comprises a rotatable vane.

15. A gas turbine engine seal system according to claim 12, wherein:

said engine component forms part of an engine having a centerline;

said abradable seal material comprises a plurality of laminated layers of said polyimide foam having a lamination plane; and

said lamination plane is substantially perpendicular to said centerline.

16. A gas turbine engine seal system according to claim 15, wherein said lamination plane is substantially parallel to a radial direction of said engine and substantially perpendicular to an axial direction of said engine.

17. A gas turbine engine seal system according to claim 12, wherein said seal substrate comprises a component formed from a polymer composite.

18. A gas turbine engine seal system according to claim 12, wherein said densified polyimide foam comprises a thermomechanically densified polyimide foam.

19. A gas turbine engine seal system according to claim 12, wherein said polyimide foam has a density of at least 10 pounds per cubic foot.

20. A gas turbine engine seal system according to claim 12, wherein said polyimide foam has a density of at least 15 pounds per cubic foot.

21. A gas turbine engine seal system according to claim 12, wherein said polyimide foam has a density in the range of from 12 pounds per cubic foot to 25 pounds per cubic foot.

22. A gas turbine engine seal system according to claim 12, wherein said polyimide foam has a shear strength in the range of 140 psi to 325 psi.

23. A gas turbine engine seal system according to claim 12, wherein said bond layer is formed by at least one adhesive strip.

24. A gas turbine engine seal system according to claim 12, wherein said bond layer is formed by a layer of adhesive material.

25. A method of forming an air seal having improved durability, comprising the steps of:

providing a polyimide foam;

densifying the polyimide foam to form a layer of densified polyimide foam;

providing a seal substrate; and

bonding said layer of densified polyimide foam to a seal substrate to form said air seal.

26. A method according to claim 25, wherein said polyimide foam providing step comprises providing a plurality of laminated layers of said polyimide foam.

27. A method according to claim 25, wherein said densifying step comprises thermomechanically densifying said polyimide foam.

28. A method according to claim 27, wherein said thermomechanically densifying step comprises heating the polyimide foam to a temperature greater than 550 degrees Fahrenheit for a time sufficient to obtain a density greater than 10 pounds per cubic foot and compressing the heated polyimide foam.

29. A method according to claim 25, wherein said seal substrate providing step comprises providing an engine component to which said polyimide foam is to be bonded.

30. A method according to claim 25, wherein said bonding step comprises applying a bonding material to a surface of said polyimide foam and applying pressure to bond said bonding material to said seal substrate.

31. A method according to claim 30, wherein said bonding material applying step comprises applying at least one adhesive strip to said polyimide foam surface.

32. A method according to claim 25, further comprising curing said air seal after said bonding step.

33. A method according to claim 32, wherein said curing step comprises:

placing said air seal in an autoclave;

applying a vacuum to said air seal in said autoclave;

applying an autoclave pressure in the range of 8 psi to 12 psi;

ramping the temperature in said autoclave from an initial temperature in the range of from 65 degrees Fahrenheit to 85 degrees Fahrenheit to a second temperature in the range of from 400 degrees Fahrenheit to 420 degrees Fahrenheit;

maintaining said second temperature for a time period in the range of 30 minutes to 1.5 hours; and

cooling said air seal.

34. A method according to claim 33, wherein said ramping step is carried out a ramp rate of from 3 degrees Fahrenheit per minute to 4 degrees Fahrenheit per minute.

35. A method according to claim 34, wherein said cooling step is carried out at a cooling rate of 3 degrees Fahrenheit per minute to 5 degrees Fahrenheit per minute.

36. A method according to claim 32, further comprising placing said air seal in an oven after completion of said curing step and postcuring said air seal.

37. A method according to claim 36, further comprising drying said air seal prior to placing said air seal in said oven.

38. A method according to claim 37, wherein said drying step comprises heating said air seal to a temperature in the range of 225 degrees Fahrenheit to 275 degrees Fahrenheit for a time period in the range of 1 hour to 48 hours.

39. A method according to claim 36, wherein said postcuring step comprises:

heating said oven to an initial temperature in the range of 65 degrees Fahrenheit to 85 degrees Fahrenheit;

ramping said initial temperature to a second temperature in the range of 630 degrees Fahrenheit to 670 degrees Fahrenheit;

holding said air seal at said second temperature for a time in the range of 60 minutes to 150 minutes; and

thereafter cooling said air seal.

40. A method according to claim 39, wherein said ramping step is performed at a ramp rate of 1.5 degrees Fahrenheit per minute to 4 degrees Fahrenheit per minute.

41. A method according to claim 40, wherein said cooling step is performed at a rate in the range of from 3 degrees Fahrenheit per minute to 5 degrees Fahrenheit per minute.

42. A method according to claim 25, wherein said densifying step comprises densifying said polyimide foam to have a density greater than 10 pounds per cubic foot.

43. A method according to claim 25, wherein said densifying step comprises densifying said polyimide foam to have a density greater than 15 pounds per cubic foot.

44. A method according to claim 25, wherein said densifying step comprises densifying said polyimide foam to have a density in the range of from 12 pounds per cubic foot to 25 pounds per cubic foot.